WORK PLAN FOR CAUSTIC BRINE POOL REMOVAL ACTION: POST-PHASE 3

LCP CHEMICALS SITE
BRUNSWICK, GEORGIA

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WORK PLAN FOR CAUSTIC BRINE POOL REMOVAL ACTION: POST-PHASE 3 REVISION 1

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1 INTRODUCTION

Honeywell is a Responsible Party ("RP") to an Administrative Order of Consent ("AOC") with the U.S. Environmental Protection Agency ("EPA"), to perform a removal response action for a condition known as the Caustic Brine Pool ("CBP") at the LCP Chemicals Superfund Site (the "Site") located in Brunswick, Georgia. Honeywell completed three phases of *in situ* treatment of the CBP over a 3-year timeframe (2013-2016), and submitted a Technical Memorandum on March 8, 2018 entitled *Update on Water Quality After CO_2 Sparging*. That memorandum focused on an evaluation of a Fall 2017 groundwater sampling event to determine whether there had been rebound of the groundwater condition. The report concluded that the post-treatement conditon remained stable with no rebound in the region of the CO_2 treatment, as monitored by the network of shallow monitoring wells above the cemented sandstone layer (i.e., upper 50 feet (ft) of the hydrogeologic setting).

Subsequently on May 10, 2018, EPA issued a letter requesting a workplan for additional work to be performed by Honeywell under the AOC. Specifically, EPA has requested that Honeywell develop additional information regarding the water quality condition in three of the Horizontal Wells (HWW-2, -3, and -4) in an underlying aquifer zone beneath the sandstone layer, and the environmental condition beneath the area of the former Cell Buildings.

Section 2 of this workplan provides an updated conceptual site model ("CSM"), including information pertaining to the hydrogeologic setting of the focus area, and the environmental condition of the subsurface in this area of the Site. Section 3 provides the framework for the additional action requested by the EPA and the proposed scope of work, in the context of pending site characterization work under a separate AOC for the Remedial Investigation / Feasibility Study ("RI/FS") of the groundwater Operable Unit ("OU"-2). Section 4 provides the proposed schedule for the work.

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2 UPDATED CSM FOR THE CBP

2.1 Overview

The CSM related to the CBP dates back to the original OU-2 Remedial Investigation ("RI") report (GeoSyntec, 1997) with some refinements over the years as additional information was collected and analyzed. The term CBP was devised to bound an altered groundwater geochemical condition resulting from a comingled release of process liquids (caustic, and brine). The primary condition used to define the CBP is a pH in excess of 10.5 Standard Units (where metals solubility is greatly increased), with other general indicators including elevated salinity, elevated metals (mercury, arsenic, chromium), and reduced oxidation-reduction potential.

The lithostratigraphic nomenclature used in the RI dates back to Huddlestun (1988), and the stratigraphic nomenclature and associated hydrologic unit designations have evolved since that time as a result of additional studies performed along coastal Georgia for the Miocene-aged and post Miocene-aged portion of the Floridan Aquifer System. The CSM has been updated herein to reflect the current nomenclature and hydrologic designations.

Following the CSM update, an updated evaluation of the groundwater quality data for the CBP is provided to examine spatial patterns and temporal trends of the CBP condition following three phases of CO_2 sparging treatment over the period of 2013-2016.

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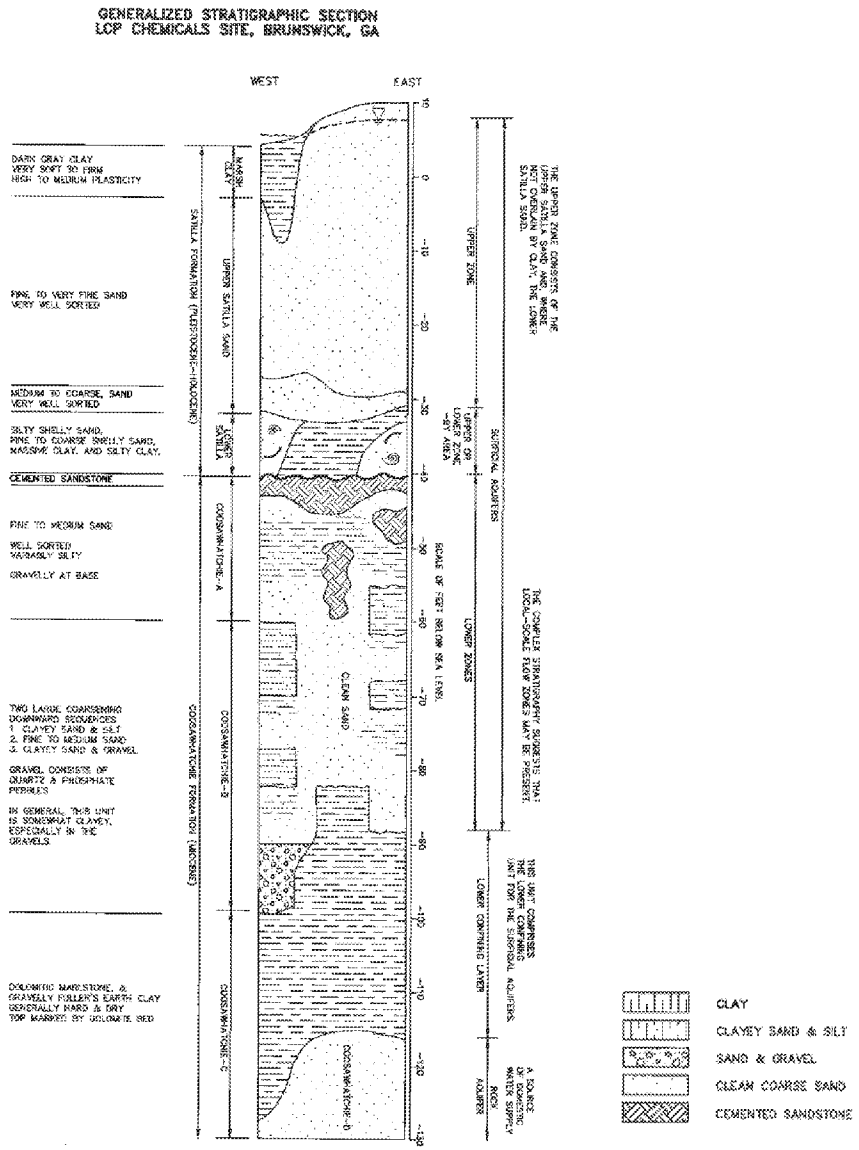
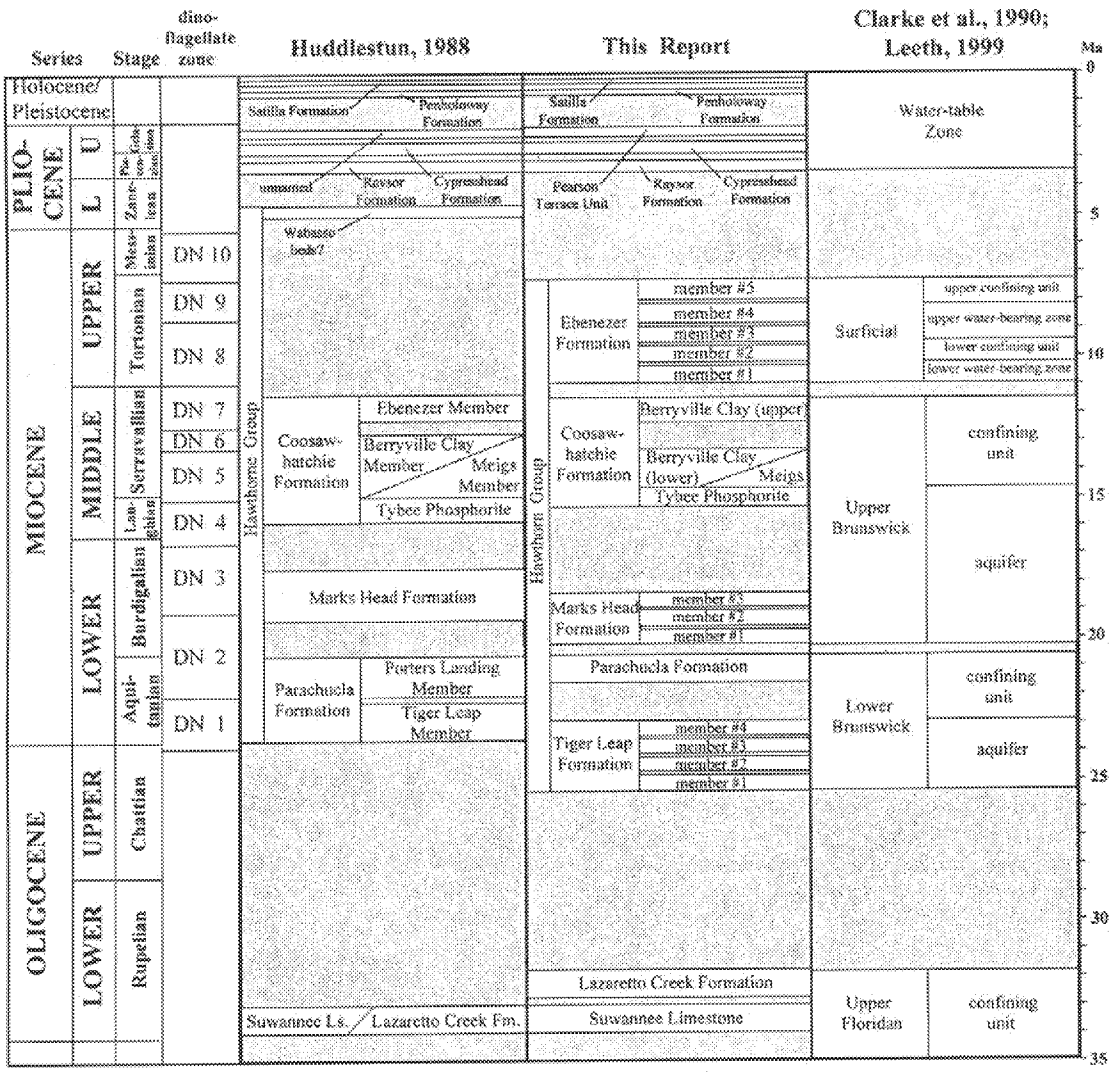
2.2 Hydrogeologic Setting

The generalized stratigraphic setting of the LCP site presented in the original RI Report is illustrated below.

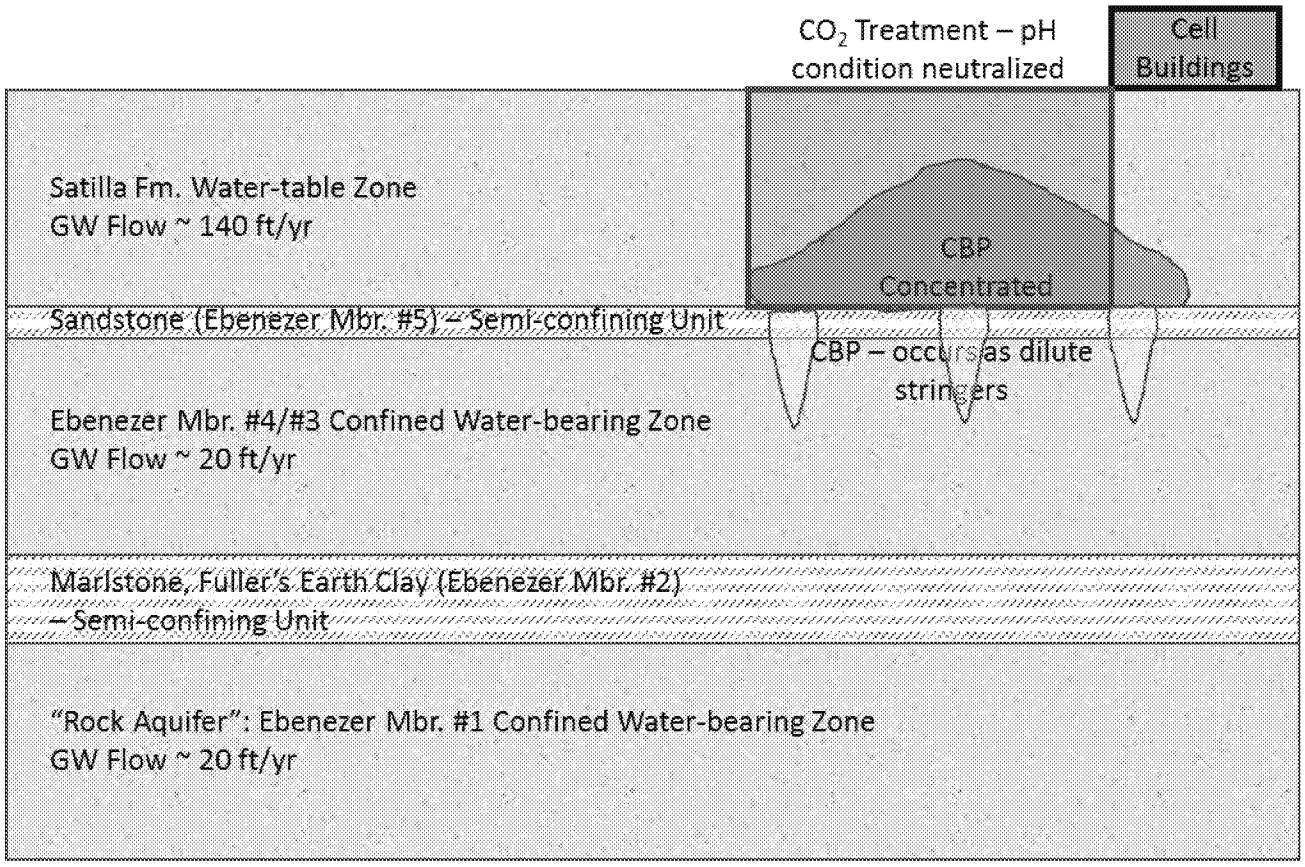


More contemporary geologic studies of the surficial aquifers of Miocene-aged and post Miocene-aged sediments of the coastal area of Georgia performed by the U.S. Geological Survey ("USGS") and others have altered and refined the nomenclature of earlier authors such as Huddlestun (1988). These studies have been published in a number of Georgia Geological Survey Information Circulars, publications by the USGS, and engineering consultants (Steele and McDowell, 1998; Leeth, 1999; Weems and Edwards, 2001; Gill, 2001; Radtke, 2001; Clarke, 2003; Cherry et al., 2011; Gill et al., 2011). A key change involves raising the rank of the Ebenezer Member ("Mbr.") of the Coosawhatchie Formation ("Fm.") to formation status (Weems and Edwards, 2001). The illustration below captured from Weems and Edwards (2001) illustrates these changes (Weems and Edwards designation is labeled "This Report" below).



There are conflicting depictions of the Upper Miocene and post-Miocene hydrologic systems, in some publications lumped as the "Surficial Aquifer System" and in other publications separated into the "Water-table Zone" and "Surficial Confined Water-bearing Zones". For the purposes of this CSM, the latter terminology is adopted to describe the hydrologic unit designations at the Site.

The CBP largely occurs within the Water-table Zone perched atop a sandstone layer present at approximately 50 feet below ground surface ("ft-bgs") which acts hydrologically as a semi-confining layer (Ebenezer #5 Mbr.). Localized seepage of CBP through the sandstone has resulted in some amount of the condition affecting the first water-bearing zone of the Surficial Aquifer (Ebenezer Mbr. #4/#3, described in the RI Report as the Coosawhatchie A/B unit). This zone is monitored by the network of "D" vertical monitoring wells and the "HW" horizontal monitoring wells on the Site. A marlstone (fuller's earth) confining layer is located beneath this zone, at a depth of approximately 100 ft-bgs and approximately 30-ft thick (described in the RI Report as the Coosawhatchie C unit). The Ebenezer Mbr. #1 water-bearing zone (approximately 50-ft thick) is the lowermost portion of the Surficial Aquifer described in the RI Report as the "Rock Aquifer". A generalized CSM is provided below.



2.3 Environmental Conditions

2.3.1 Overview

The following presentation of the environmental conditions in the CBP area focuses on pH and mercury in the Satilla Fm. in the vicinity of the Cell Buildings Area ("CBA") not treated by CO2 sparging, and in the underlying Ebenezer Mbr. #4/#3 monitored by the D and HW wells. Data are presented both spatially and temporally.

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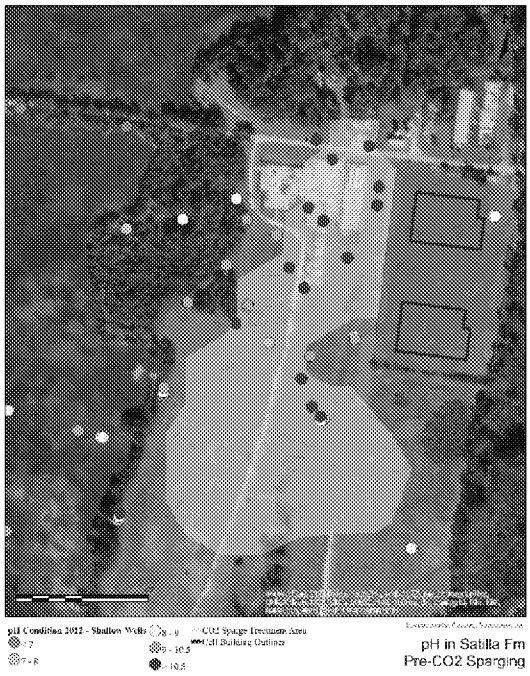
2.3.2 Effects of CO_2 Treatment

The spatial distribution of the pH and mercury ("Hg") condition in the Satilla Fm. pre- (2012 sampling event) and post- (2017 sampling event) CO_2 treatment is shown in the figures below. The neutralization of the pH condition in the treatment zone (blue shaded region) is evident by comparison of Figures 1a and 1b. A corresponding general improvement in the mercury condition is also evident in the treatment zone by comparison of Figures 1c and 1d. Both the pH and mercury condition in wells outside the treatment zone are largely unchanged (stable).



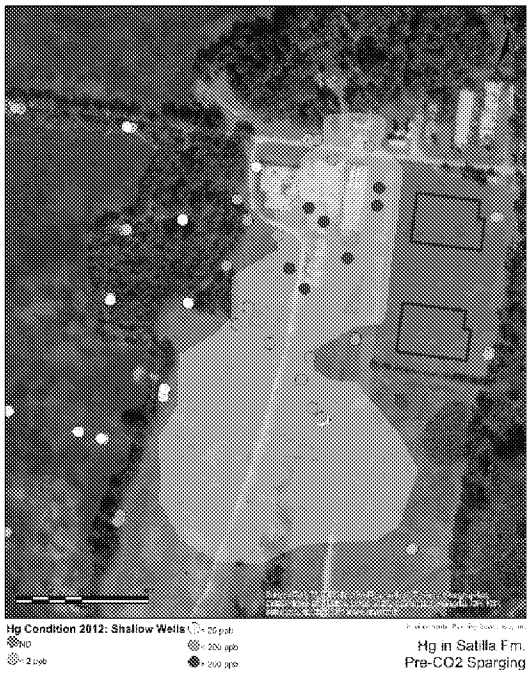


Figure No. 1c

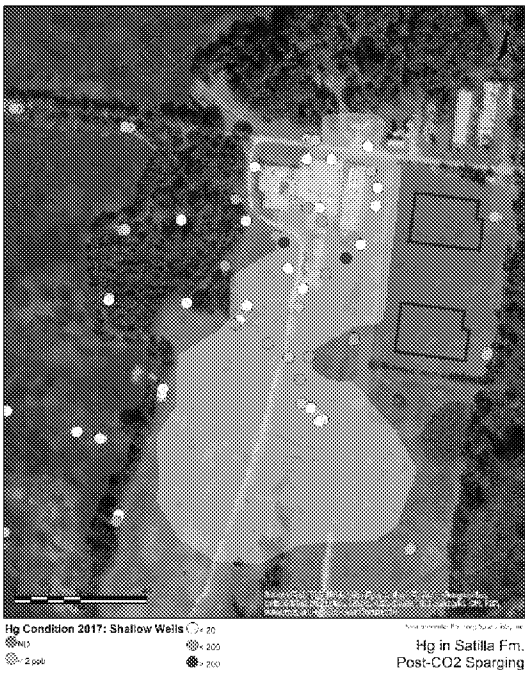


Figure No. 1d

The treatment design basis was to reduce the pH in the overlying Satilla Fm. where the CBP condition was most concentrated and spatially continuous. No treatment was applied to the underlying Ebenezer Fm. and as shown in the next Section 2.3.3, conditions were not affected by the treatment (as was expected). Given the units are separated by an aquitard, additional time beyond the 2017 sampling event will be necessary for the underlying Ebenezer aquifer to experience a positive influence from the CO_2 treatment.

2.3.3 Temporal Trends

2.3.3.1 East Horizontal Well Alignment and Nearby D Wells

The area immediately down-gradient of the former Cell Buildings is monitored by the eastern horizontal well alignment (HWEast-1 through -6, from north to south), and by vertical monitoring wells MW-352D, MW-360D, and MW-115D (Figure 3). Table 1a presents the monitoring history for the six CBP parameters for these wells.

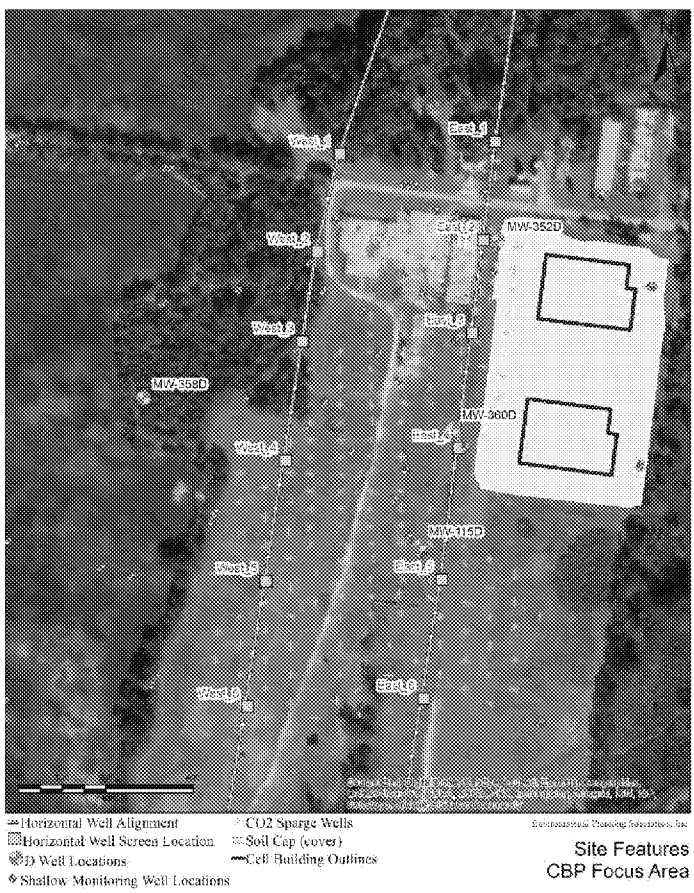


Figure No. 3

Four of the wells on the eastern alignment show some level of water quality change over time, all located west-southwest of Cell Building 2:

- HWEast-4;
- HWEast-5;
- MW-115D; and
- MW-360D.

Time-trend graphs for these four wells are provided below – solid connecting lines are used for the HWs and dashed connecting lines are used for the D wells to help distinguish between the two types of wells. The first set of graphs illustrate the pH and Eh condition, and the second set of graphs illustrate the mercury and chromium condition, and the last set of graphs illustrate the chloride and arsenic condition. The blue shaded box captures the points along the temporal timeline where conditions most notably changed. Note that temporal monitoring of the D wells dates back to 1996-97 whereas monitoring of the HW wells began in 2002, so the time trend data points do not originate at the same origin on the graphs. Monitoring was performed on a generally routine (annual to biannual) basis through to 2012, and resumed in 2016 at the conclusion of phase 3 of the CO_2 treatment and performed again on a site-wide basis in 2017.

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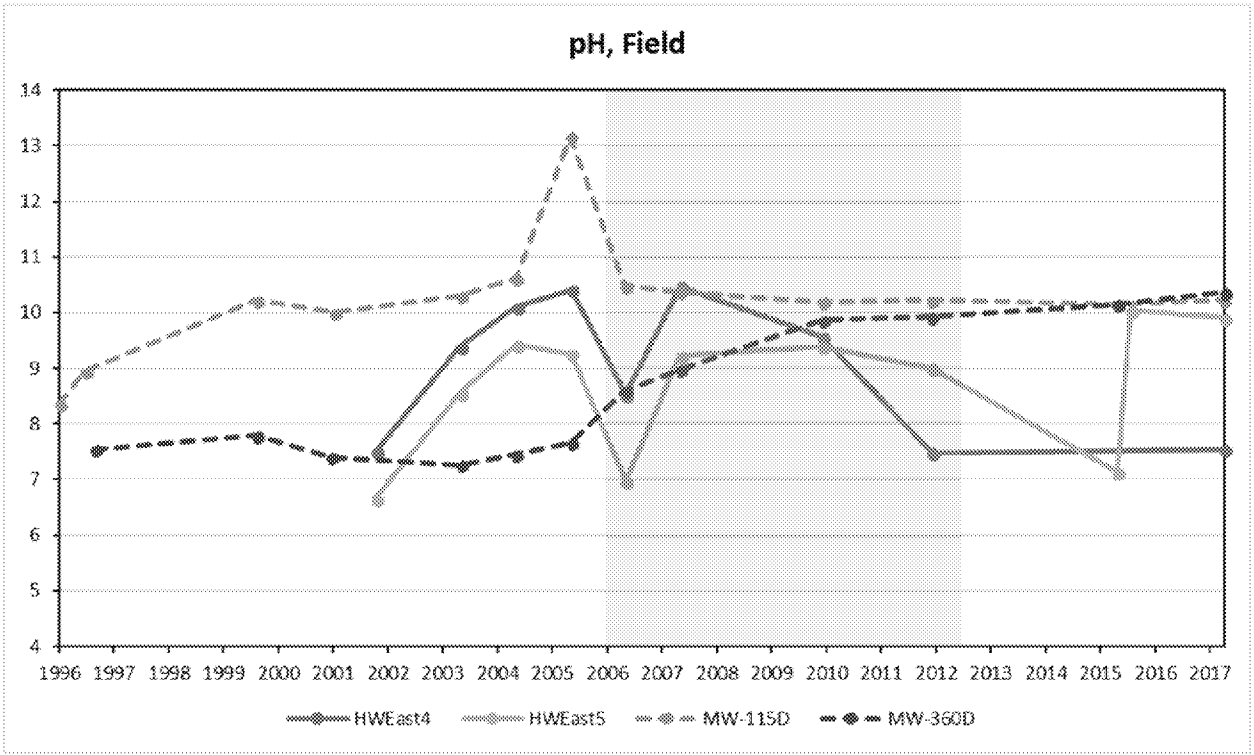
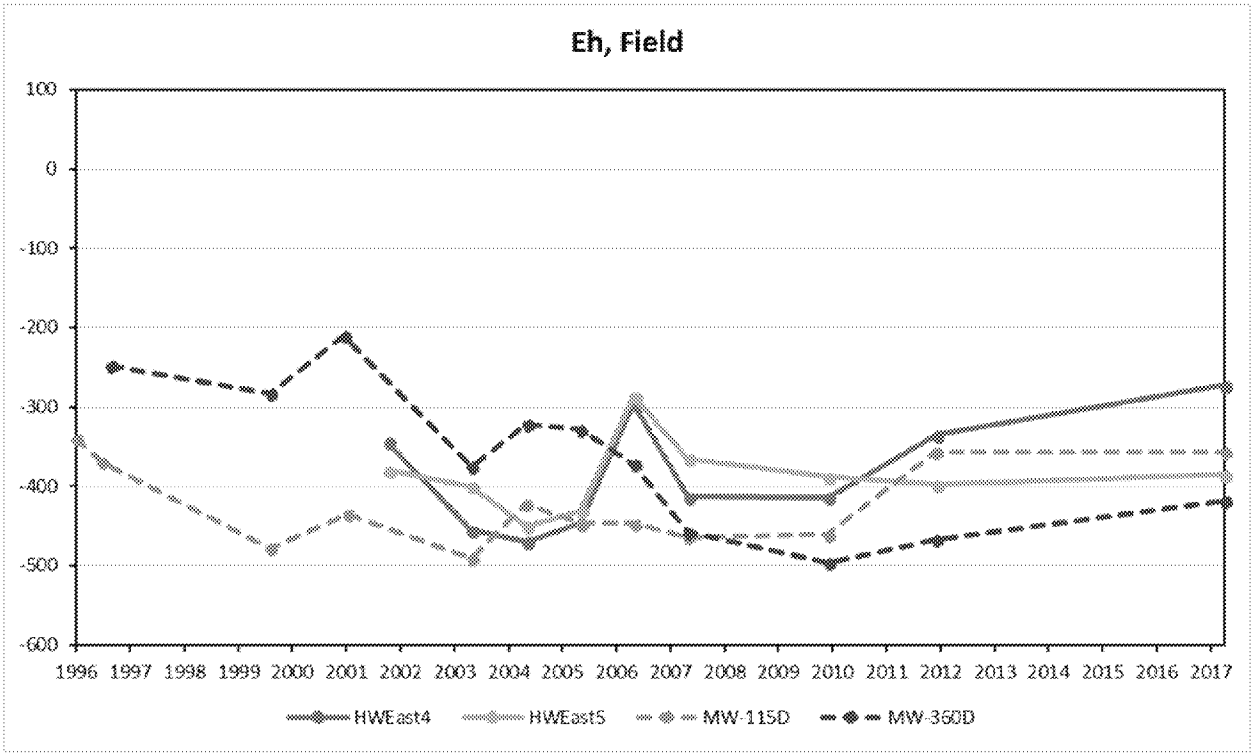
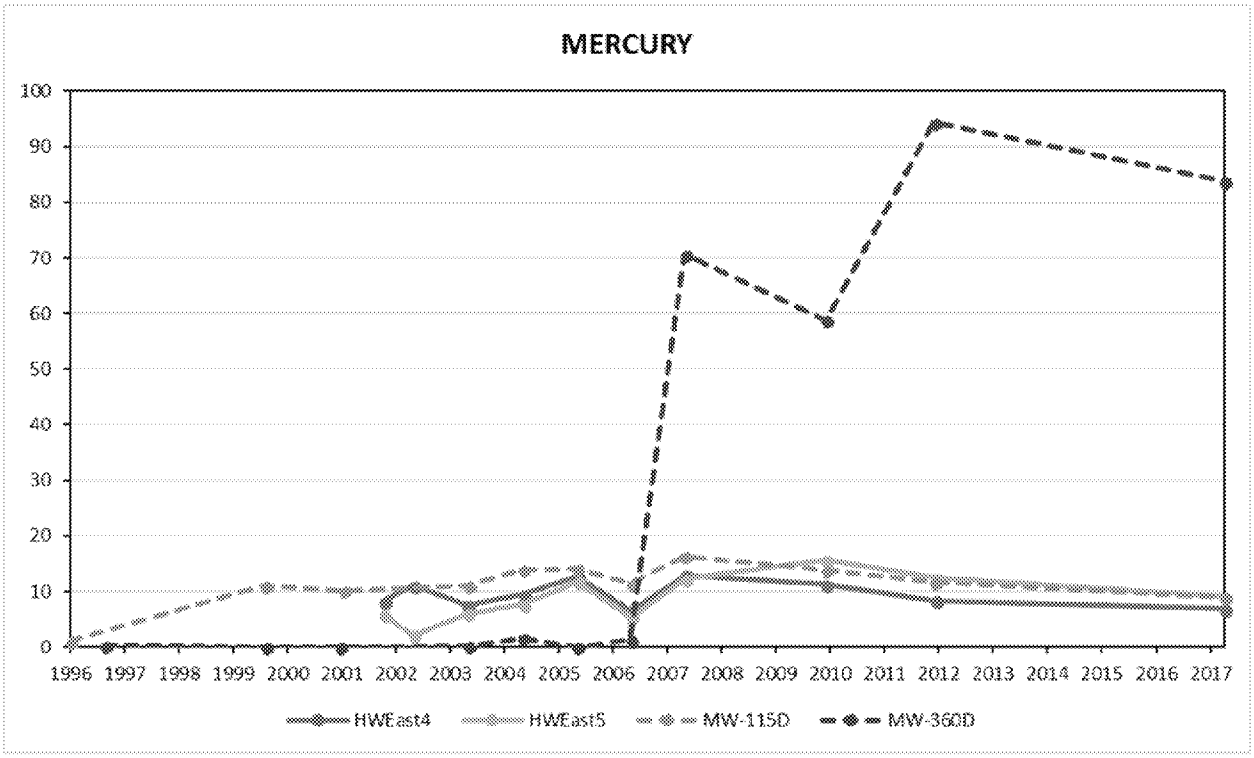

pH, Field
14
13
12
11
10
9
8
7
6
5
4
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017
HWEast4
HWEast5
MW-115D
MW-360D


Eh, Field
100
0
-100
-200
-300
-400
-500
-600
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017
HWEast4
HWEast5
MW-115D
MW-360D


MERCURY
100
90
80
70
60
50
40
30
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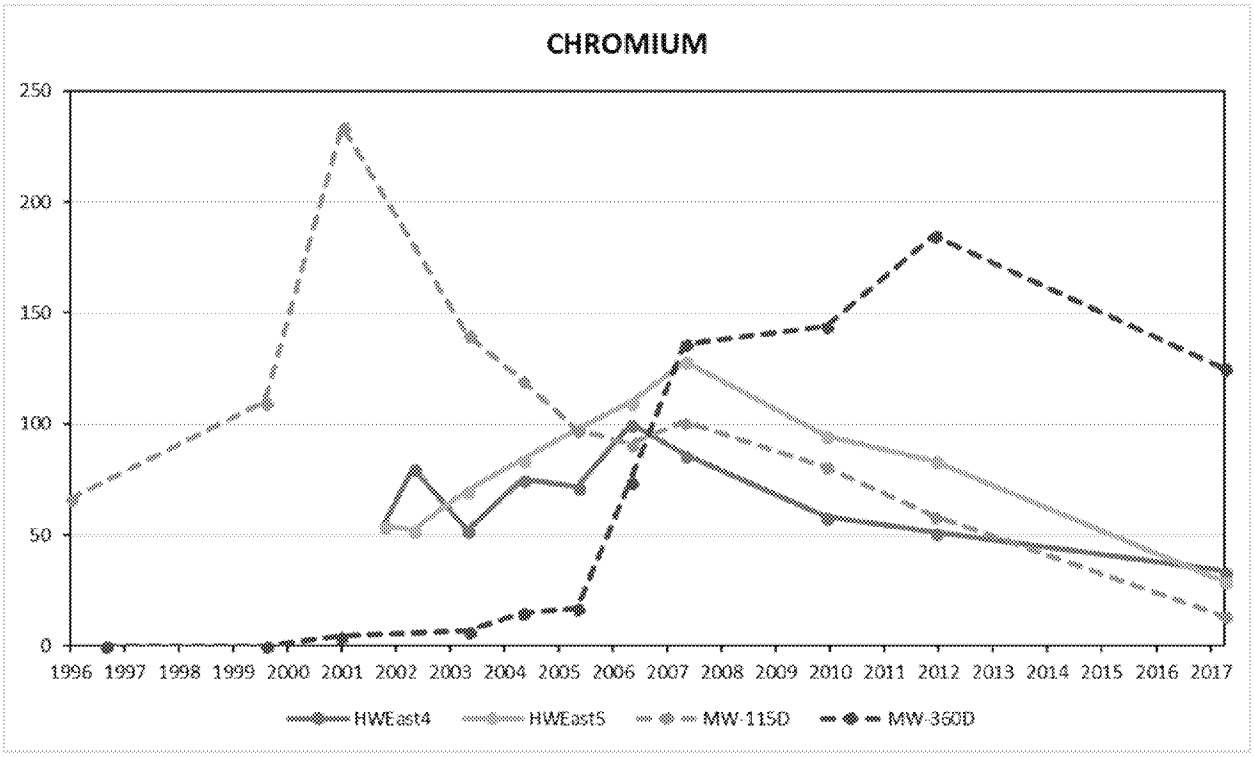
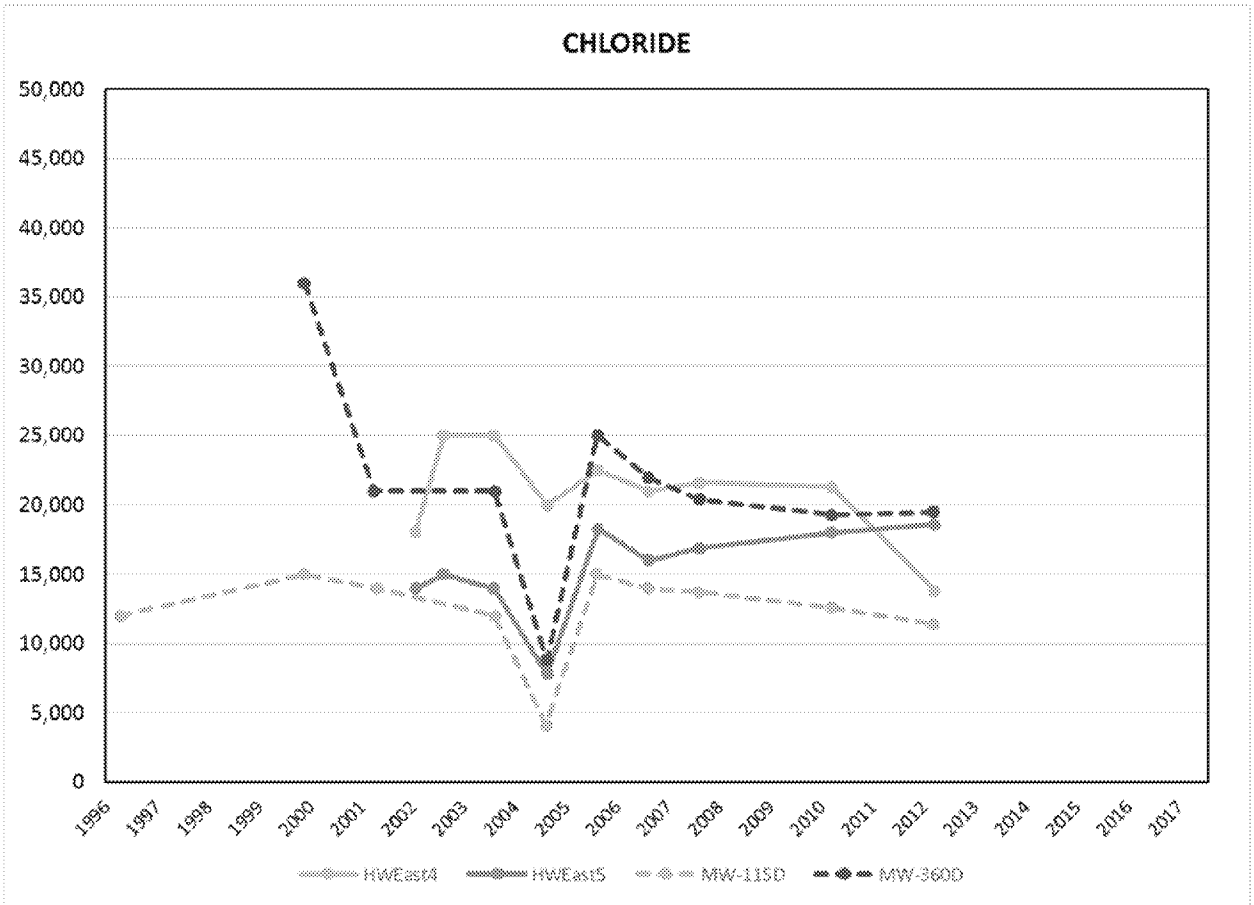
10
0
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017
HWEast4
HWEast5
MW-115D
MW-360D


CHROMIUM
250
200
150
100
50
0
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017
HWEast4
HWEast5
MW-115D
MW-360D


CHLORIDE
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15,000
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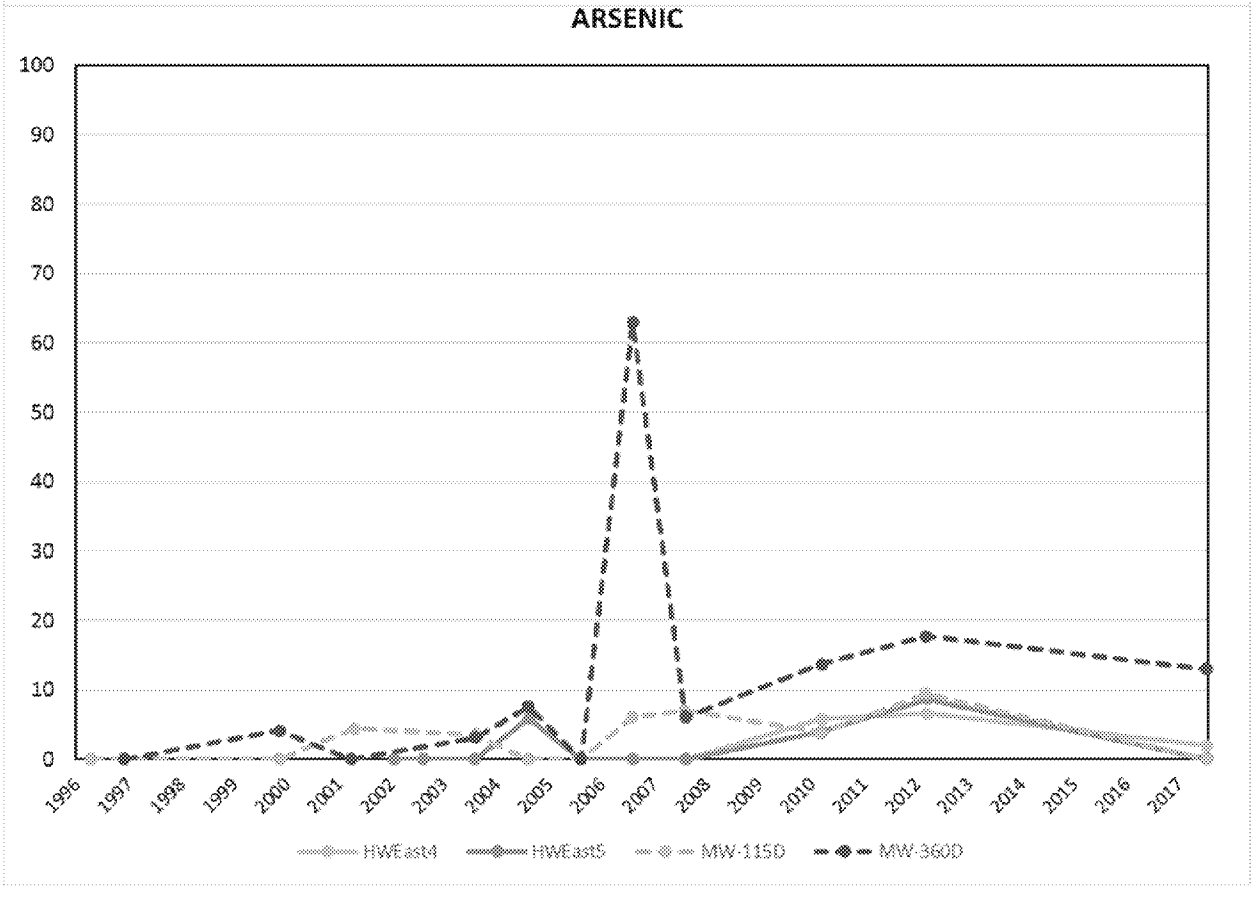
HWEast4
HWEast5
MW-115D
MW-360D


ARSENIC
100
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2016
2017
HWEast4
HWEast5
MW-115D
MW-360D

Well MW-115D (gray dashed line) showed modest indications of the CBP condition in the early monitoring period and conditions peaked/plateaued around 2000-2001 and have remained generally stable since. Well MW-360D (dark blue dashed line) exhibited trace CBP conditions over this timespan, then exhibited a period of worsening conditions from about 2006-2012. Note the rise in pH in well MW-360D from approximately 7.5 to 10 and corresponding decrease in ORP and increase in dissolved metals - (shown by blue shading in the graphs) after which time conditions appear to have stabilized. Well HWEast-4 (orange solid line) and HWEast-5 (light blue solid line) track similarly for each of the six CBP indicators, showing a slight influence on the water quality, and with a generally stable condition over the last 8-10 years.

2.3.3.2 West Horizontal Well Alignment and Nearby D Wells

The western horizontal well alignment (HWWest-1 through -6, from north to south) extends along or somewhat beyond the down-gradient extent of the overlying CBP treatment zone (Figure 3). Vertical monitoring well MW-358D is approximately 350 ft further west of this horizontal well. Table 1b presents the monitoring history for the six CBP parameters for these wells.

Four of the wells on the western alignment show some level of water quality change over time:

- HWWest-2;
- HWWest-3;
- HWWest-4; and
- HWWest-5.

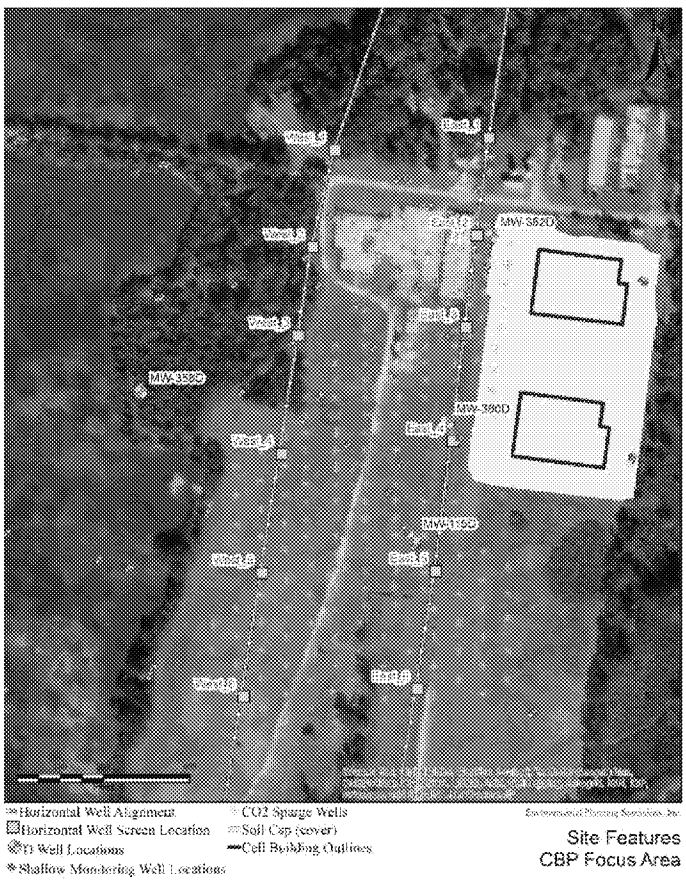
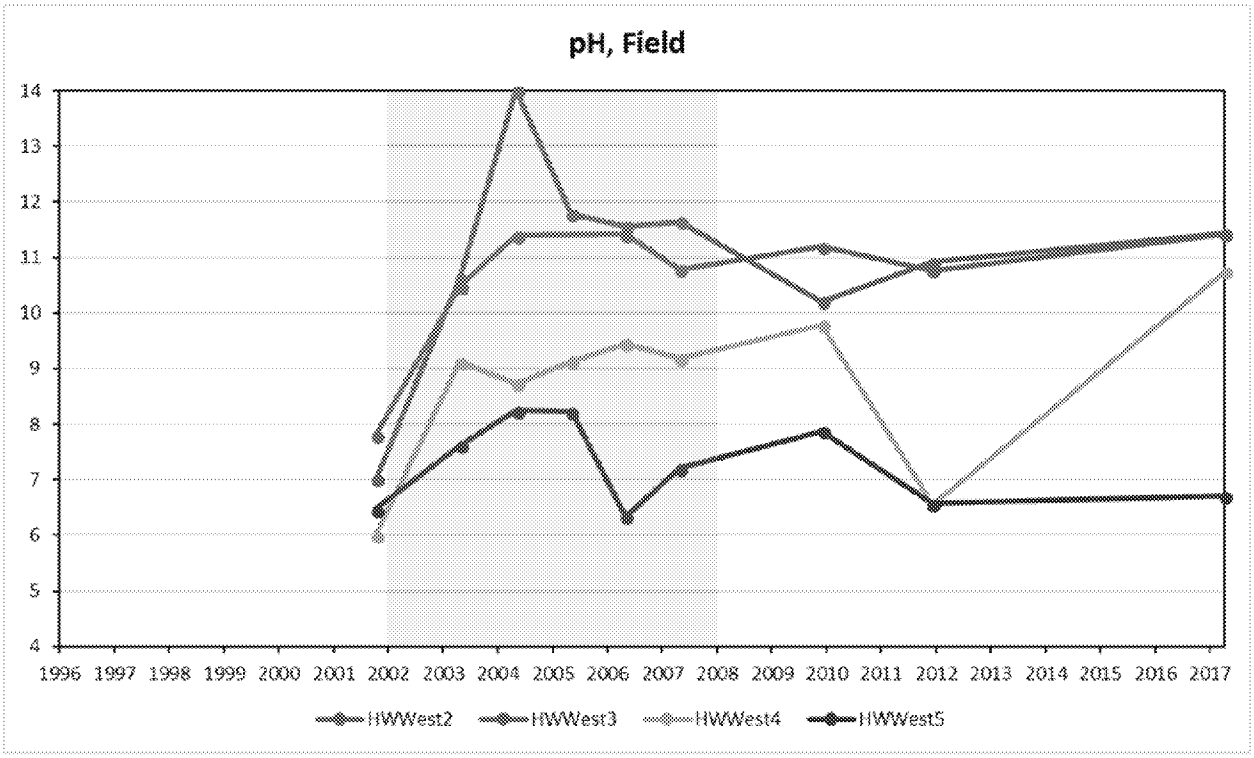


Figure No. 3

Time-trend graphs for these four wells are provided below. The same parameters and graphing conventions used for the eastern alignment wells previously presented are used below.


pH, Field
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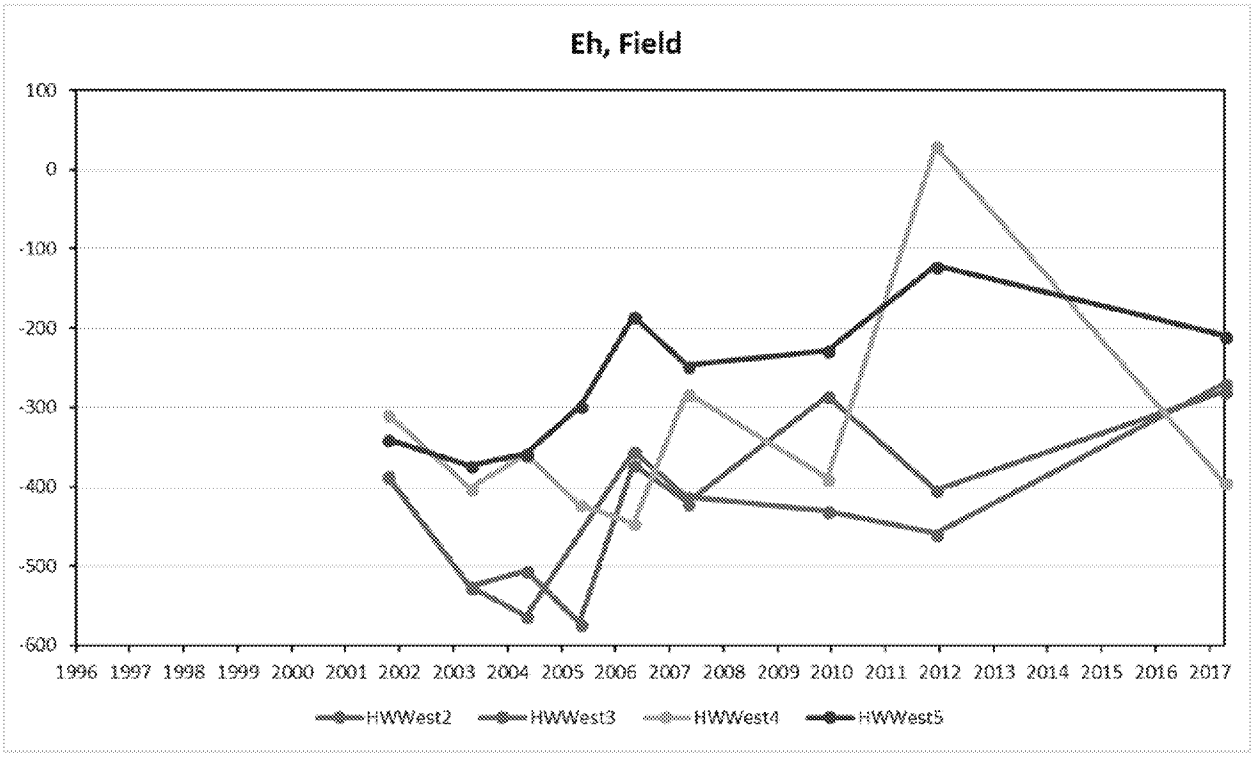
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017
HWWest2
HWWest3
HWWest4
HWWest5


Eh, Field
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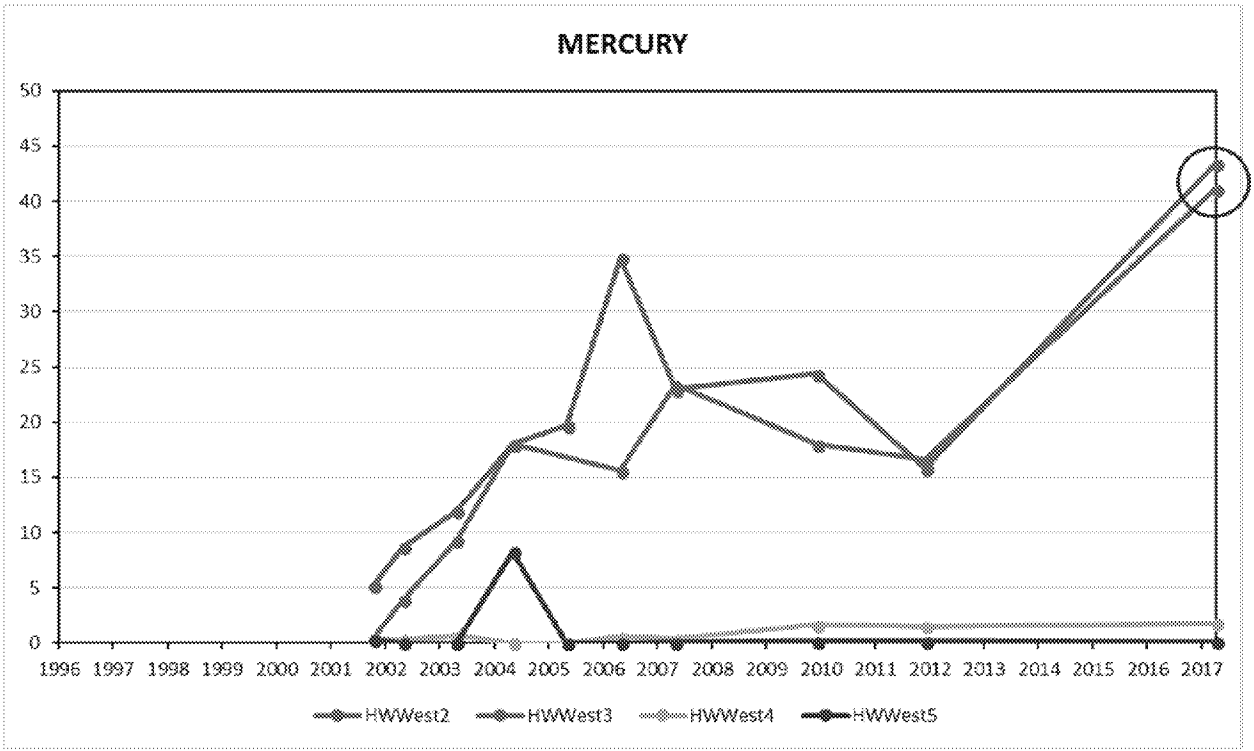
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017
HWWest2
HWWest3
HWWest4
HWWest5


MERCURY
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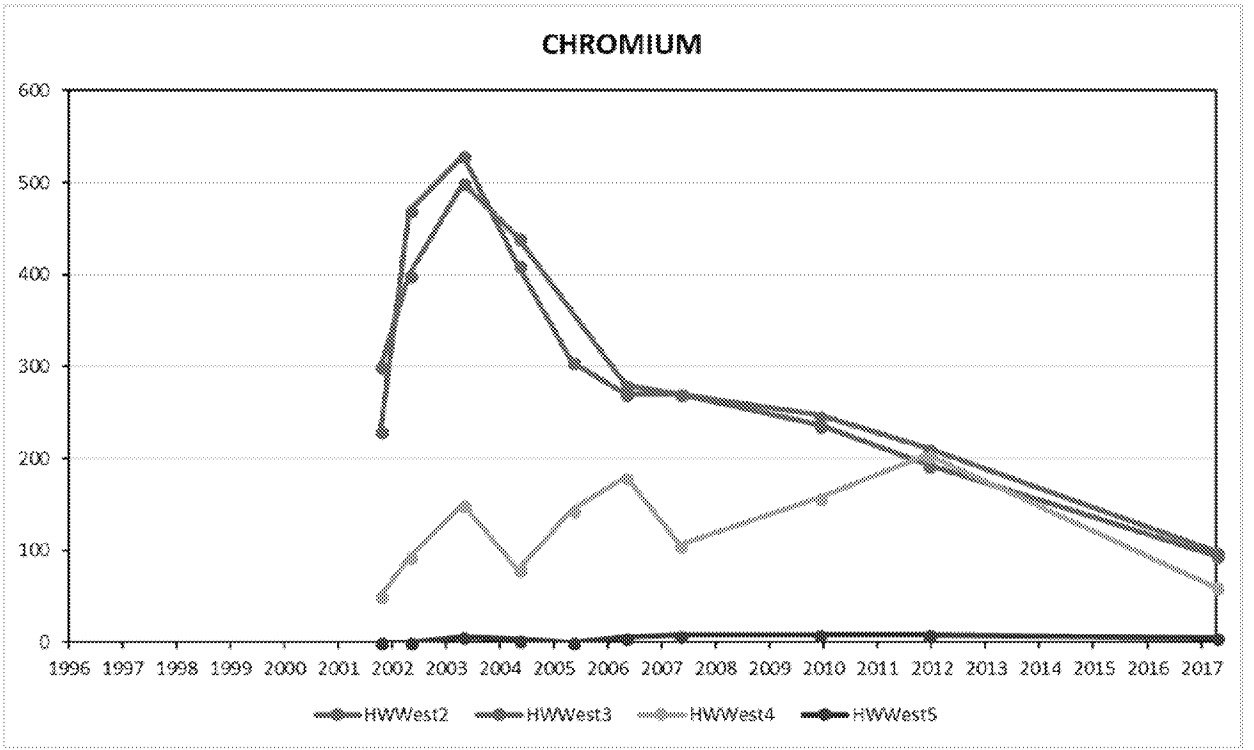
HWWest2
HWWest3
HWWest4
HWWest5


CHROMIUM
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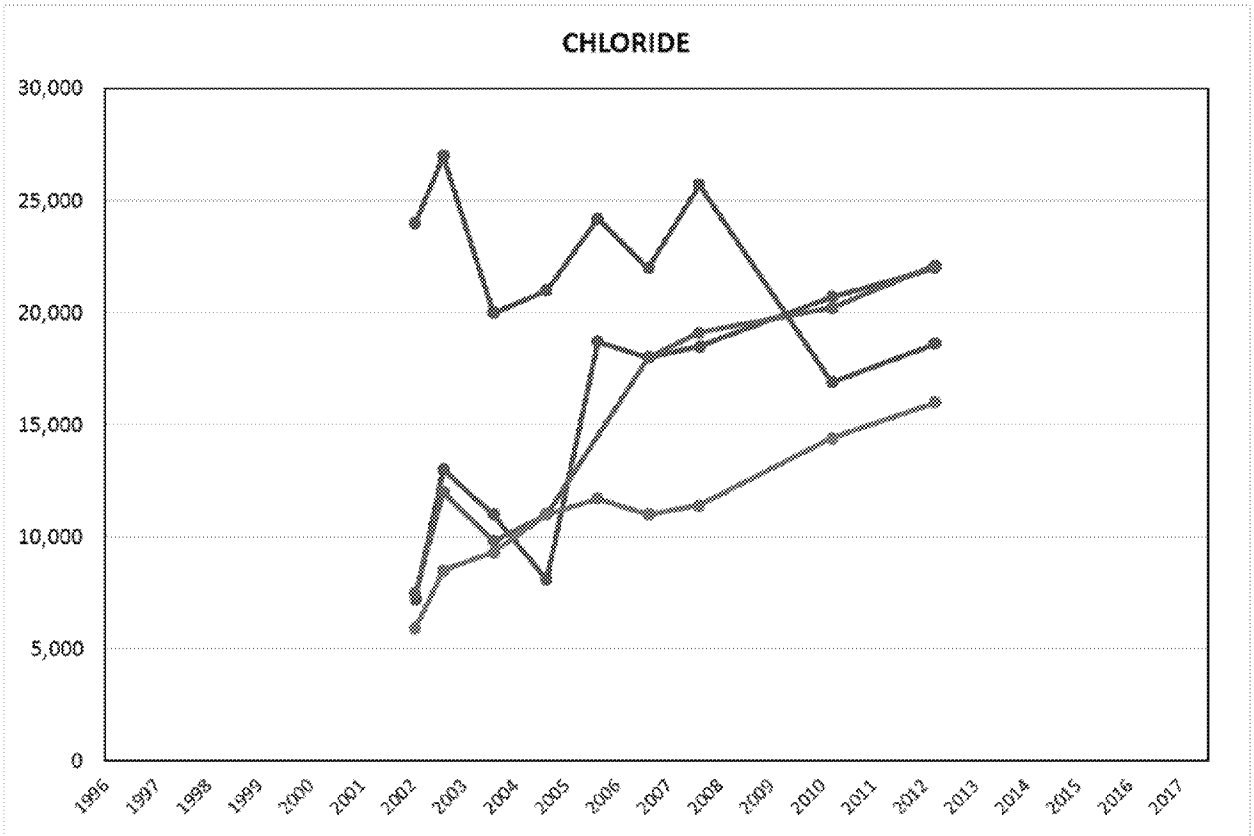
1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017
HWWest2
HWWest3
HWWest4
HWWest5


CHLORIDE
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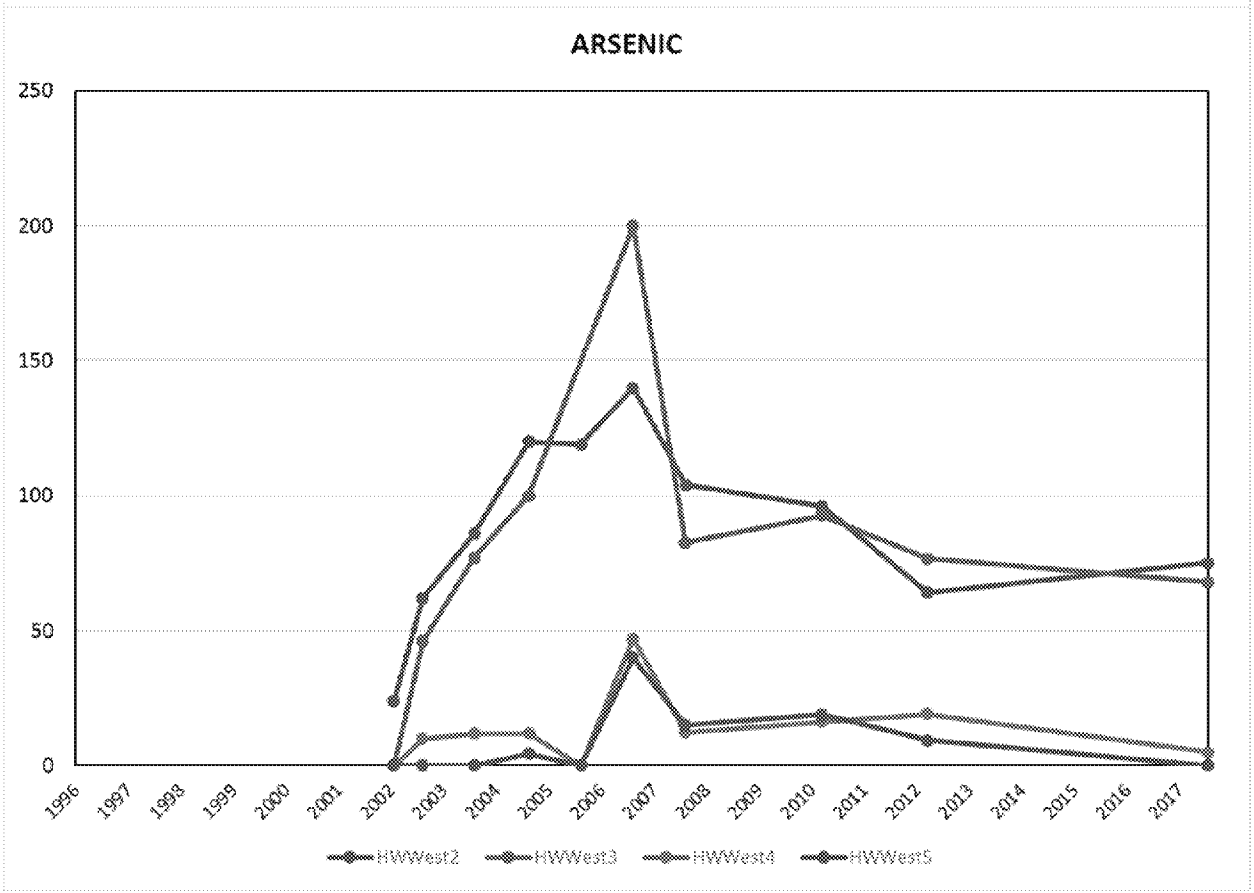
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2017
HWWest2
HWWest3
HWWest4
HWWest5

The western HW wells show a higher CBP signature compared to the eastern wells, with generally higher metals concentration and higher pH. The early time period shows a relatively rapid increase in dissolved metals and pH (blue shaded region of the graphs above), then generally stabilizes/declines beginning around the 2008-9 timeframe. Mercury in wells HW-West2 and 3 is a possible exception to this observation, where the 2017 sampling event (red circle in chart above) represents a significantly higher concentration compared to the prior sampling event in 2012 or earlier years. It is unknown whether this represents an increasing trend or sampling anomalies (outliers). We also note the other two metals did not show a corresponding condition in 2017.

2.4 Discussion

The spatial analysis and time trend review depicts a dilute CBP condition in the aquifer zone beneath the sandstone semi-confining layer, more pronounced in the western horizontal well alignment and bounded further down-gradient by well MW-358D. Many of the water quality parameters in the CBP show a relatively stable condition in this western alignment over the last 10 years, although a few of the water quality parameter results are confounding:

- Chloride shows a generally increasing (worsening) trend, whereas Eh shows a trend towards a less negative redox condition (improving); and
- Arsenic and chromium show a stable to declining trend, while the trend for mercury is unclear (owing to the 2017 results for two of the wells).

Data from the HW and D wells in the eastern alignment shows less influence by the CBP, with the exception of MW-360D. This well is confounding in that it exhibited negligible CBP influence over the first 10 years of monitoring, followed by a sharp increase in all three metals concentrations with a corresponding increase in pH and decrease in Eh over a period from about 2006 – 2012. This pattern is not corroborated by the nearby HWEast-4 well.

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3 FRAMEWORK AND SCOPE OF WORK

3.1 Pending Scope of Work for OU2 / CBA Site Characterization

As part of the OU2 RI, Honeywell will be undertaking additional characterization of the subsurface conditions beneath the former Cell Buildings in the near future (upon approval of a pending review of a set of project plans submitted in April 2018). Boring/testing locations were chosen primarily to assess and delineate the extent of metallic mercury potentially in the Water-table Aquifer beneath the Cell Buildings. An added work scope element involves offset borings for water quality profiling (CBP parameters). The following is an excerpt from the April 2018 OU2 RI/Cell Building Area (CBA) Site Characterization Workplan.

> Profiling of the CBP will be accomplished with direct-push groundwater sampling[1] performed from the water table to the base of the Satilla Formation in an offset boring to the soil core borings [11 locations]. The presence of the CBP will be ascertained in real-time via downhole conductivity measurements, and further confirmed through visual assessment and testing of groundwater purged from discrete sampling zones. Groundwater will be purged at a vertical frequency of approximately 4 ft coinciding with soil core samples from the adjacent boring, and tested for general water-quality parameters (*i.e.*, temperature, pH, conductivity, redox potential, dissolved oxygen).

The OU2 RI/CBA workplan also calls for installation and sampling of two well clusters beneath the buildings' area, as well as sampling of the existing monitoring well network down-gradient (including the deeper D and HW wells – see table below). This work is anticipated to occur in early fall of 2018, approximately one year from the last groundwater monitoring event of September 2017.

Wells Proposed for Sampling Under the Cell Building Area / OU2 RI Workplan

MW-105A	MW-115B	MW-354A	MW-358D	MW-504A	MW-509A	MW-514A	HWEast1
MW-105B	MW-115C	MW-354B	MW-359A	MW-504B	MW-509B	MW-514B	HWEast2
MW-105C	MW-115D	MW-355A	MW-359B	MW-505A	MW-510A	MW-515A	HWEast3
MW-112A	MW-351A	MW-355B	MW-360D	MW-505B	MW-510B	MW-515B	HWEast4
MW-112B	MW-351B	MW-356A	MW-501A	MW-506A	MW-511A	MW-516A	HWEast5
MW-112C	MW-352A	MW-356B	MW-501B	MW-506B	MW-511B	MW-516B	HWEast6
MW-113A	MW-352B	MW-357A	MW-502A	MW-507A	MW-512A	MW-517A	HWWest1
MW-113B	MW-352D	MW-357B	MW-502B	MW-507B	MW-512B	MW-517B	HWWest2
MW-113C	MW-353A	MW-358A	MW-503A	MW-508A	MW-513A	MW-518A	HWWest3
MW-115A	MW-353B	MW-358B	MW-503B	MW-508B	MW-513B	MW-518B	HWWest4
						MW-519A	HWWest5
						MW-519B	HWWest6

[1] Profiling and sampling will be accomplished through use of the Waterloo Advanced Profiling System tool.

3.2 Additional Work Scope for the CBP Removal Action

Additional work scope to that being performed under the OU2 RI is proposed herein, in response to EPA's request for additional CBP response action. Figure 4 below shows the CBA and locations planned for assessment under the pending OU2/CBA workplan, and additional locations proposed in this new workplan:

- Gray circles depict deep soil borings performed in 1996 where high pH was noted (in pore water);
- Aqua asterisks depict sparge wells with the pre-treatment mercury condition posted;
- Yellow triangles depict proposed locations for addition deep soil borings, which will include offset borings for CBP parameters vertical profiling;
- Existing monitoring wells (blue/white circle) will be sampled for OU2;
- Two additional monitoring well clusters (black/white circle) will be installed and sampled for OU2; and
- Five additional CBP profiling borings are proposed herein to further delineate the CBP.

Figure No. 4

Additional temporal monitoring over the next two years is proposed to support the CBP Removal Action evaluation process. Specifically, we propose to perform semi-annual monitoring for the monitoring wells screened in the Ebenezer Fm. (HW and D monitoring wells).

4 SCHEDULE

The OU2 RI/CBA site characterization will commence within thirty (30) days of EPA's review and approval of the project plans.

The first of four CBP monitoring events is anticipated to occur in early fall of 2018 (*i.e.*, subject to EPA's approval of the OU2 RI/CBA project plans). Thus, we anticipate that the CBP monitoring will extend through to the fall of 2020. This timing intersects with the anticipated schedule for the OU2 Feasibility Study ("FS"), such that a a comprehensive removal/remedial response action can be developed.

ED_006371_00001897-00020

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ED_006371_00001897-00021

Table 1A.
Monitoring History for CBP Parameters:
Eastern Horizontal Well Alignment and Associated Vertical Wells

Location/ Date	Arsenic µg/L	Chromium µg/L	Eh, field mV	Mercury µg/L	pH, field Std. Units	Salinity, field %
HWEast1						
04/03/02	ND	ND	-235	ND	6.20	0.5
10/23/02	ND	ND	NS	ND	NS	NS
10/17/03	ND	1.7	-213	ND	6.37	NS
10/29/04	ND	ND	-183	2.0	6.44	0.5
10/28/05	ND	ND	-211	ND	6.62	0.7
10/23/06	ND	1.8	-117	0.0004	6.58	0.6
10/25/07	ND	6.5	-174	0.0015	6.45	NS
05/28/10	2.1	1.6	-158	0.0025	6.38	0.7
05/31/12	2.2	1.8	-142	0.01	6.51	NS
09/27/17	ND	6.7	-139	0.06	6.75	0.7
HWEast2						
04/03/02	ND	15.0	-170	ND	5.90	0.5
10/23/02	ND	ND	NS	ND	NS	NS
10/17/03	ND	ND	-272	ND	6.20	NS
10/29/04	ND	ND	-221	ND	6.32	0.4
10/28/05	ND	ND	-198	ND	7.03	NS
10/23/06	ND	1.1	-155	0.0002	7.44	0.5
10/25/07	1.0	6.9	-188	0.0010	8.47	0.5
05/28/10	2.9	0.77	-165	0.0014	6.31	0.7
05/31/12	ND	0.82	-138	0.0016	6.58	0.7
10/15/15	NS	NS	NS	NS	6.38	NS
01/14/16	NS	NS	NS	NS	7.56	NS
09/27/17	ND	0.40	-102	0.0019	6.63	0.6
HWEast3						
04/03/02	ND	11.0	-184	ND	5.88	0.2
10/23/02	ND	ND	NS	ND	NS	NS
10/17/03	ND	ND	-252	ND	6.38	NS
10/29/04	ND	ND	-225	ND	6.64	0.3
10/28/05	ND	ND	-209	ND	6.75	NS
10/23/06	ND	1.5	-235	0.0002	6.51	0.2
10/25/07	0.91	5.9	-184	0.00091	6.61	NS
05/28/10	2.1	ND	-144	0.00043	6.76	0.2
05/31/12	1.8	0.59	-110	0.00035	6.63	NS
10/15/15	NS	NS	NS	NS	6.32	NS
01/14/16	NS	NS	NS	NS	7.00	NS
09/27/17	ND	ND	-100	0.00077	6.87	0.4

µg/L: micrograms per liter
mV: millivolts
Std. Units: standard pH units
%: percent

ND: non-detect
NS: not sampled

Table 1A.
Monitoring History for CBP Parameters:
Eastern Horizontal Well Alignment and Associated Vertical Wells

Location/ Date	Arsenic µg/L	Chromium µg/L	Eh, field mV	Mercury µg/L	pH, field Std. Units	Salinity, field %
HWEast4						
04/03/02	ND	54	-344	8.3	7.50	0.3
10/23/02	ND	80	NS	11.0	NS	NS
10/17/03	ND	52	-455	7.6	9.39	NS
10/29/04	5.9	75	-470	9.5	10.10	4.0
10/27/05	ND	72	-447	12.7	10.41	NS
10/23/06	ND	100	-296	6.6	8.53	3.0
10/25/07	ND	86	-413	12.9	10.47	3.3
05/28/10	5.9	58	-414	11.2	9.57	3.9
05/31/12	6.6	51	-335	8.4	7.48	3.8
09/27/17	2.0	34	-272	6.9	7.54	4.1
HWEast5						
04/03/02	ND	54	-380	5.8	6.66	3.1
10/23/02	ND	52	NS	2.2	NS	NS
10/17/03	ND	70	-400	6.0	8.55	NS
10/29/04	5.9	84	-450	7.7	9.43	4.0
10/27/05	ND	98	-431	11.7	9.26	NS
10/23/06	ND	110	-286	5.3	6.97	2.8
10/25/07	ND	128	-365	12.2	9.23	2.5
05/28/10	4.0	95	-388	15.6	9.40	3.3
05/31/12	8.7	83	-398	12.4	9.00	NS
10/15/15	NS	NS	NS	NS	7.13	NS
01/14/16	NS	NS	NS	NS	10.04	NS
09/27/17	ND	29	-385	9.1	9.90	1.8
HWEast6						
04/03/02	ND	54	-231	2.4	6.50	0.6
10/23/02	ND	16.0	NS	0.34	NS	NS
10/17/03	ND	28	-318	0.63	6.36	NS
10/29/04	ND	8.0	-291	ND	6.49	0.3
10/27/05	ND	6.9	-280	ND	6.74	0.1
10/23/06	ND	5.4	-201	0.08	7.45	0.1
10/25/07	0.98	20	-267	0.19	6.41	NS
05/28/10	0.82	12.6	-177	0.12	6.54	0.2
05/31/12	2.8	11.4	-230	0.13	6.56	0.2
09/27/17	0.70	6.1	-223	0.03	6.19	0.0

µg/L: micrograms per liter
mV: millivolts
Std. Units: standard pH units
%: percent

ND: non-detect
NS: not sampled

Table 1A.
Monitoring History for CBP Parameters:
Eastern Horizontal Well Alignment and Associated Vertical Wells

Location/ Date	Arsenic µg/L	Chromium µg/L	Eh, field mV	Mercury µg/L	pH, field Std. Units	Salinity, field %
MW-115D						
06/26/96	ND	66	-340	1.1	8.36	NS
12/16/96	NS	NS	-369	NS	8.95	NS
01/28/00	ND	110	-478	11.0	10.22	NS
07/03/01	4.4	234	-435	10.1	10.00	2.9
10/21/03	3.6	140	-491	11.0	10.30	NS
10/23/04	ND	120	-422	13.9	10.62	3.4
10/22/05	ND	97	-447	14.1	13.16	3.4
10/20/06	6.1	91	-447	11.4	10.48	2.7
10/18/07	7.1	101	-464	16.3	10.37	1.2
05/25/10	3.8	81	-461	13.8	10.19	2.3
05/22/12	9.5	59	-357	11.6	10.22	NS
10/15/15	NS	NS	NS	NS	10.14	NS
09/23/17	ND	13.6	-357	8.9	10.22	2.1
MW-352D						
06/26/96	ND	ND	-96	ND	6.85	NS
02/01/00	ND	ND	-138	ND	7.12	NS
06/22/01	ND	ND	-104	ND	6.70	0.2
10/22/03	ND	1.8	-170	ND	6.96	NS
10/22/04	ND	ND	-114	ND	6.94	0.2
10/21/05	ND	ND	-124	ND	6.68	NS
10/20/06	ND	ND	-102	0.0021	7.24	0.1
10/17/07	ND	5.8	-114	0.0015	6.92	0.1
05/25/10	ND	0.93	-112	0.00312	7.27	0.2
06/02/12	0.41	0.51	-121	0.00247	6.35	0.3
10/15/15	NS	NS	NS	NS	6.84	NS
10/01/17	ND	0.26	-85	0.01	6.59	0.4
MW-360D						
02/14/97	ND	ND	-248	0.33	7.54	NS
01/28/00	4.1	ND	-283	ND	7.79	NS
06/09/01	ND	4.2	-210	ND	7.40	1.2
10/22/03	3.1	6.7	-375	0.21	7.26	NS
10/25/04	7.6	15.0	-322	1.6	7.45	4.0
10/24/05	ND	16.9	-328	ND	7.66	4.0
10/21/06	63	74	-372	1.3	8.60	3.8
10/21/07	6.0	136	-458	71	8.98	NS
05/26/10	13.7	144	-496	59	9.86	3.5
05/23/12	17.7	185	-467	94	9.92	NS
10/15/15	NS	NS	NS	NS	10.15	NS
09/25/17	13.0	125	-418	84	10.36	2.7

µg/L: micrograms per liter
mV: millivolts
Std. Units: standard pH units
%: percent

ND: non-detect
NS: not sampled

Table 1B.
Monitoring History for CBP Parameters:
Western Horizontal Well Alignment and Associated Vertical Wells

Location/ Date	Arsenic µg/L	Chromium µg/L	Eh, field mV	Mercury µg/L	pH, field Std. Units	Salinity, field %
HWWest1						
04/04/02	ND	21	-207	0.33	5.70	0.6
10/21/02	ND	15.0	NS	ND	NS	NS
10/15/03	ND	19.0	-323	0.23	6.92	NS
10/28/04	3.9	14.0	-419	ND	8.40	0.9
10/27/05	ND	20	-478	ND	9.57	NS
10/22/06	38	19.0	-368	1.1	9.68	0.7
10/22/07	6.4	19.1	-392	1.4	9.36	0.4
05/27/10	10.2	19.7	-389	2.0	9.65	1.3
05/30/12	9.5	28	-364	2.2	8.15	1.3
09/30/17	5.4	16.0	-365	2.3	9.21	1.5
HWWest2						
04/05/02	24	230	-387	5.2	7.03	1.9
10/22/02	62	470	NS	8.7	NS	NS
10/15/03	86	530	-525	12.0	10.63	NS
10/28/04	120	410	-506	18.0	14.00	3.4
10/26/05	119	305	-572	19.7	11.78	NS
10/23/06	140	270	-372	35	11.56	NS
10/25/07	104	270	-420	23	11.64	3.4
05/27/10	96	236	-285	24	10.21	3.5
05/30/12	64	193	-404	15.8	10.92	NS
09/30/17	75	95	-280	43	11.43	3.5
HWWest3						
04/04/02	ND	300	-386	0.44	7.80	0.3
10/22/02	46	400	NS	3.9	NS	NS
10/15/03	77	500	-526	9.3	10.48	NS
10/28/04	100	440	-563	18.0	11.39	4.0
10/22/06	200	280	-355	15.6	11.41	2.9
10/22/07	83	270	-412	23	10.79	2.2
05/27/10	93	247	-430	18.0	11.19	4.1
05/30/12	77	211	-459	16.6	10.77	NS
09/30/17	68	99	-270	41	11.42	3.4

µg/L: micrograms per liter
mV: millivolts
Std. Units: standard pH units
%: percent

ND: non-detect
NS: not sampled

Table 1B.
Monitoring History for CBP Parameters:
Western Horizontal Well Alignment and Associated Vertical Wells

Location/ Date	Arsenic µg/L	Chromium µg/L	Eh, field mV	Mercury µg/L	pH, field Std. Units	Salinity, field %
HWWest4						
04/04/02	ND	50	-308	0.44	6.00	0.8
10/22/02	10.0	93	NS	0.30	NS	NS
10/15/03	12.0	150	-402	0.64	9.12	NS
10/28/04	12.0	79	-360	ND	8.73	2.3
10/26/05	ND	144	-422	ND	9.13	2.3
10/22/06	47	180	-446	0.58	9.45	2.2
10/22/07	12.4	106	-282	0.36	9.18	1.4
05/27/10	16.3	157	-389	1.6	9.79	1.4
05/30/12	19.1	204	30	1.5	6.56	3.1
09/30/17	5.0	60	-394	1.8	10.75	3.3
HWWest5						
04/04/02	ND	ND	-340	0.30	6.47	4.0
10/22/02	ND	ND	NS	ND	NS	NS
10/15/03	ND	5.7	-373	ND	7.62	NS
10/28/04	4.4	3.1	-358	8.3	8.24	4.0
10/27/05	ND	ND	-298	ND	8.22	4.0
10/22/06	40	5.2	-185	0.03	6.34	4.0
10/22/07	15.1	7.7	-247	0.05	7.21	1.7
05/27/10	18.9	8.3	-228	0.18	7.88	1.4
05/30/12	9.4	8.4	-121	0.16	6.57	NS
09/30/17	ND	4.9	-209	0.11	6.71	1.8
HWWest6						
04/04/02	ND	11.0	-352	0.40	9.41	4.0
10/22/02	ND	10.0	NS	ND	NS	NS
10/16/03	ND	16.0	-395	ND	9.64	NS
10/28/04	5.4	7.6	-382	ND	9.52	4.0
10/27/05	ND	14.5	-386	ND	9.57	NS
10/22/06	56	20	-59	0.18	9.04	4.0
10/22/07	39	24	94	0.20	6.93	NS
05/27/10	48	10.9	-34	0.14	8.48	5.1
05/30/12	15.9	9.7	213	0.11	7.10	NS
09/30/17	ND	4.8	120	0.10	6.97	3.4

µg/L: micrograms per liter
mV: millivolts
Std. Units: standard pH units
%: percent

ND: non-detect
NS: not sampled

Table 1B.
Monitoring History for CBP Parameters:
Western Horizontal Well Alignment and Associated Vertical Wells

Location/ Date	Arsenic µg/L	Chromium µg/L	Eh, field mV	Mercury µg/L	pH, field Std. Units	Salinity, field %
MW-358D						
07/10/96	ND	ND	-234	0.21	8.17	NS
12/13/96	NS	NS	-252	NS	8.09	NS
02/02/00	6.0	ND	-289	ND	8.32	NS
06/15/01	ND	1.1	-207	0.20	8.06	ND
10/16/03	ND	7.1	-212	ND	7.76	NS
10/26/04	3.8	ND	-204	ND	7.35	4.0
10/24/05	ND	ND	-195	ND	7.15	NS
10/22/06	53	4.4	-170	0.06	7.47	4.0
10/18/07	ND	19.0	-207	0.05	7.87	3.0
05/31/10	14.7	7.2	134	0.02	7.77	4.0
05/22/12	7.1	5.0	-186	0.02	6.94	4.0
09/06/17	0.80	2.2	-128	0.01	7.02	4.6

µg/L: micrograms per liter
mV: millivolts
Std. Units: standard pH units
%: percent

ND: non-detect
NS: not sampled